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5230

BIOLOGICAL EVALUATION FOR THE BEECH CREEK AND FRANCIS MARION SEED ORCHARDS

By

Larry R. Barber[1/]

INTRODUCTION

Seed orchard seed production is essential to the Southern Tree Improvement Program if genetic gains in improved tree form, increased volume, improved fiber characteristics and insect and disease resistance are to be realized. Anticipated future demands for forest wood products make it imperative that superior seedlings be planted to provide additional volume growth.

The main factor limiting seed production is insects. At this time, there are no known workable techniques for predicting seed orchard insect populations and their damage. Insect control procedures presently consist of a preventative spray schedule.

This biological evaluation reflects the seriousness of current and past insect infestations on the Francis Marion and Beech Creek Seed Orchards. It is expected that insect damage will continue at the same levels next year.

Major insect damages covered in this evaluation are coneworms, Dioryctria spp.; seed worms, Laspeyresia spp.; seed bugs, Leptoglossus corculus L., and Tetyra bipunctata Say; white pine cone beetle, Conophthorus coniperda (Schwartz); tipmoth, Rhyacionia spp.; and sawflies, Neodiprion spp.

1/ Entomologist, Forest Insect and Disease Management Group, Southeastern Area, State and Private Forestry, Asheville, N.C.

METHODS

Beech Creek Seed Orchard

Data from the Beech Creek Seed Orchard Virginia pine, Pinus virginiana Mill. impact study were used for part of this evaluation. Ten percent of the flower clusters from selected clones were tagged during March 1973 and checked monthly throughout the 18 month growth period recording cone mortality and other cone loss factors.

In September 1975, the mature cones were harvested, the seed extracted, radiographed and germinated. No insecticidal sprays were used on the test trees.

Eastern white pine, Pinus strobus L. seed lots were collected from three geographic seed sources. The mature seed was radiographed and germinated.

A two percent survey of the Eastern white pine using random starts was conducted June 20, 1975 to indicate losses of second year cones from white pine cone beetles.

Francis Marion Seed Orchard

Seed orchard personnel picked mature cones from 20 loblolly pine, Pinus taeda L. clones during October 1975. The seed were extracted, radiographed, and germinated with information recorded for each seed lot.

A survey of the entire orchard for sawflies was conducted during March 1976. The survey included ramdon sampling of three rows in each block and every fifth tree in each of those rows. Data were recorded for number of trees infested and the number of sawfly colonies present in each infested tree.

Twenty field collected cones picked at random from Georgia shortleaf and South Carolina Piedmont loblolly pine trees were sent to the Eastern Tree Seed Laboratory in Macon, Georgia for examination.

RESULTS

Beech Creek Seed Orchard

Only 75 cones were harvested in September 1975 from the Virginia pine impact study, out of 260 female strobili present at cone initiation. This represents a 71.3 percent conelet and cone loss (Table 1). The 75 cones produced 1,906 full seeds for an average of 25.4 full seeds per cone (Table 2). The seed orchard efficiency for the 260 Virginia pine

Table 1. Conelet and cone mortality causal agents for the 1975 Virginia pine cone crop harvested from the impact study - Beech Creek Seed Orchard near Murphy, North Carolina

Mortality Factor	Percent
Missing unknown	22.3
Aborted dead unknown	36.5
Attacked dead unknown insect	1.2
Attacked dead *Dioryctria* spp.	.4
Missing tags lost	7.0
Missing weather	2.7
Attacked dead unknown	1.2
Total Cone Crop Lost	71.3

Table 2. Cone and seed analysis for Virginia pine impact study on the Beech Creek Seed Orchard near Murphy, North Carolina.

Female strobili at beginning of study - March 1974	260
Cones at end of study - September 1975	75
Seed potential for 260 cones @ 88 seed per cone	22,880
Seed potential for 75 cones @ 88 per cone	6,600
Seed yield for 75 cones (full seed)	1,906
Harvested cone seed efficiency 1906/6600	28.9%
Seed orchard seed efficiency 1906/22880	8.3%
Full seed per cone	25.4
Seedling efficiency 1655/22880	7.2

was 8.3 percent. Most of the cone and seed losses while identified as aborted and missing, 36.5 percent and 22.3 percent respectively, are probably the result of seedbug attacks to the developing conelets and cones. These attacks cause the conelets and cones to abort and fall from the tree with no apparent sign of attack. Radiograph analysis of the harvested seed showed 7.2 percent identifiable seedbug damage and 19 percent empty seed (Table 3). Empty seed results from inbreeding and seedbug attack. Seed worm seed losses were 0.3 percent

White pine cones were collected by geographic source, the seed extracted, X-rayed and germinated. Identifiable seedbug losses were 2.3 percent while 18.7 percent of the seed were empty (Table 4).

The June 20, 1975 survey of the Eastern white pine showed that 78 percent of the 1975 cone crop was destroyed by the white pine cone beetle.

Francis Marion Seed Orchard

Analysis of seed extracted from 20 clones showed that the Georgia loblolly had 2 percent identifiable seedbug loss while the Marion loblolly source had 12 percent identifiable seedbug loss with empty seed accounting for 14 percent and 17 percent, respectively (Table 5). One percent of the Marion loblolly pine seed were damaged by seedworm

Data from the cone analysis survey (CAS) of twenty cones from the Georgia shortleaf and South Carolina piedmont loblolly pine showed no seed worm damage while identifiable seedbug damage was 0.0 and 0.4 percent respectively. First year ovule abortion for the Georgia shortleaf was 70.9 percent and 32.4 percent for the South Carolina piedmont loblolly.

An April 1976 sawfly evaluation (Table 6) showed that up to 60 percent of the shortleaf and loblolly pines were infested with sawflies, Neodiprion excitans Rohwer. An October 1975 survey showed 47.9 percent of the Georgia shortleaf were infested.

No evaluations were made for either pine needle scale, or coneworm losses in 1975 for either orchard. Insect recommendation contained herein are justified on the basis of past historical evaluations. (Appendices 1 and 2) These pests are present and continue to threaten the orchard trees.

In a 1975 Furadan(R) test, treated cones produced 107 seed/cone more than cones receiving no insecticides. (Appendix 3) This indicates a serious insect problem.

Table 3. Summary of X-ray analysis of Virginia pine seed from the impact study on the Beech Creek Seed Orchard near Murphy, North Carolina.

	Total Seed	Full Seed	Seedbug	Empty	Seedworm	Malformed	Germination
Number	2611	1906	187	496	9	3	1655
Percent	100	73	7.2	19	.3	.1	86.8 (full seed)

Table 4. White pine seed lot evaluation of mature seeds collected in August 1975 on the Beech Creek Seed Orchard near Murphy, North Carolina.

Source	Number	Percent							
	Total Seed	Full Seed	Seed Bug	Empty	Laspeyresia	Chalcid	Malformed	Germination of Total Seed	Germination of Full Seed
Georgia	392	78.3	1.5	19.1	0.0	0.3	0.8	74	95
Cherokee	465	77.0	1.9	20.2	0.0	0.7	0.2	73	95
N. C.	600	79.0	3.1	17.2	0.0	0.0	0.7	77	97
Total number all 3 sources	1457	1139	34	272	0.0	4.0	8.0		
Average Percent all 3 sources		78.2	2.3	18.7	0.0	0.3	0.5	75	96

Table 5. Seed evaluation from mature loblolly cones collected in the fall of 1975 on the Francis Marion Seed Orchard near Moncks Corner, South Carolina.

Clone Number	Source	Percent						
		Full Seed	Seed Bug	Empty	Laspeyresia	Malformed	Germination of Total Seed	Germination of Full Seed
49	Georgia	75	0	25	0	0	53	71
10	Georgia	89	0	11	0	0	89	100
51	Georgia	79	4	16	1	0	73	93
52	Georgia	82	3	15	0	0	81	98
11	Georgia	89	0	11	0	0	80	89
1	Georgia	77	1	22	0	0	71	92
21	Georgia	76	5	17	0	0	75	99
22	Georgia	89	1	10	0	0	87	98
18	Georgia	91	1	8	0	0	93	98
14	Georgia	73	7	20	0	0	53	73
Average		84	2	14	0	0	78	93
50	Marion	85	2	11	1	1	53	98
2	Marion	69	26	5	0	0	69	99
9	Marion	85	9	6	0	0	84	99
7	Marion	62	9	28	1	0	59	96
8	Marion	25	59	16	0	0	24	95
14	Marion	21	19	59	1	0	22	97
44	Marion	68	15	16	1	0	68	100
5	Marion	60	19	20	1	0	87	97
16	Marion	85	0	14	1	0	80	95
28	Marion	87	2	11	0	0	87	99
Average		70	12	17	1	0	69	99

Table 6. 1975 Cone Analysis Service (CAS) summary results from twenty unsprayed randomly selected mature cones harvested from South Carolina piedmont loblolly and Georgia shortleaf pine trees on the Francis Marion Seed Orchard near Moncks Corner, S. C.

Source	Seed Potential Per Cone	Percent (of potential)					
		Seedbug	Seedworm	1st year abortion	2nd year abortion	Empty	Filled
South Carolina piedmont loblolly	157.5	0.4	0.0	32.4	0.6	9.8	56.7
Georgia shortleaf	78.7	0.0	0.0	70.9	0.3	10.7	18.2

Table 7. Evaluation results of a pine sawfly survey of one shortleaf and four loblolly pine sources on the Francis Marion Seed Orchard near Moncks Corner, S. C., March 22, 1976.

	Georgia Shortleaf	Georgia Loblolly	N.C. Loblolly	Marion Loblolly	Piedmont Loblolly
Percent of trees infested	34	46	49	60	39
Number of sawfly colonies per tree	1.8	2.4	1.7	2.1	1.4
Survey sample size number of trees sampled	128	102	85	80	182
Total number of trees in source	1,891	1,695	1,052	1,177	2,315
Percent sample by source	6.8	6	8.2	6.8	7.9

Total sample as a percent - 7.1 percent

DISCUSSION

Coneworms are present on both seed orchards and have caused considerable damage to past cone crops. The Francis Marion lost 25 percent of the 1974 piedmont loblolly cone crop to coneworms. No evaluation was made of either orchard in 1975 for coneworm damage. Coneworms are still considered to be a potential major orchard pest and control measures should be continued in order to prevent losses.

Beech Creek Seed Orchard

The Virginia pine impact study showed conelet and cone losses to be heavy. The main loss factors were abortion and missing conelets and cones. Researchers feel that these losses can be attributed to feeding by seedbugs. Analysis of white pine seedlots also indicate the presence of seedbugs. Control of seedbugs should be the highest priority in future insect control projects.

The white pine cone beetle continues to be active on the orchard, destroying 79 percent of the 1975 white pine cone crop. Cone losses on this and other orchards from this pest often exceed 90 percent of the second year cones.

This insect is known to be one of the most destructive insect pests of white pine seed (Baker 1972). During certain years, entire seed crops are destroyed. Efforts must be made to control this pest.

Pine needle scale populations are present in large numbers on many shortleaf pines. Pine needle scale in dense populations can reduce shoot and needle elongation and prolonged infestation can cause tree mortality (Nielsen and Johnson 1973). In 1974, pine needle scale infested 57 percent of the Cherokee shortleaf and 20.3 percent of the North Carolina shortleaf pine (Appendix 2).

Francis Marion Seed Orchard

Radiographic analysis of 10 Marion loblolly clones by FI&DM personnel showed identifiable seedbug losses at 12 percent. The Eastern Tree Seed Laboratory at Macon, Georgia, considers 10 percent to be high and consideration should be given to insect control measures. Identifiable seedbug losses represents only the "tip of the iceburg", as the total loss cannot be detected with the methods used in 1975.

The Eastern Tree Seed Laboratory also considers first year ovule abortion to be high if it exceeds 10 percent. The Georgia shortleaf and South Carolina piedmont loblolly first year ovule abortions were 70.9 and 32.4 percent respectively and two causes are suspected. Ovules which are unpollinated or upon which seedbugs have been feeding are known to abort during the first year.

More sophisticated techniques, including bagging of cone and conelet clusters will be needed before the true impact of these losses are known.

Sawflies were found infesting orchard trees in October 1975 and again in March 1975. The orchard was subsequently sprayed after each survey temporarily eliminating the sawfly problem. It is believed that adult sawflies immigrate from the surrounding forest trees into the seed orchard and therefore sawflies will continue to be a problem. Little work has been done to document sawfly damage to seed orchard trees. Heavily defoliated trees are weakened and rendered susceptible to attack by bark beetles (Baker 1972). Wilson in 1965, working with a different sawfly and tree species, reported reduced height and diameter growth from sawfly defoliation. The probability of tree mortality from secondary pests should be included in control considerations.

Pine tortoise scale populations are present on the orchard. This insect sucks plant juices and may be a factor in reducing plant vigor. Heavy populations may result in considerable branch mortality or death to the tree (Baker 1972). While scale populations are now low control of infested trees should continue in order that they remain at low levels.

Seedworm damage to pine seed is low and is not considered a hazard to the overall orchard seed production.

SUMMARY

Insect losses to pine seeds and cones are fourfold: loss of the potential flower crop by shoot attack, loss to first year conelets, loss to second year cones and loss to seed in the cones. Overall loss to the seed crop on the two Federal seed orchards was considerable during 1975.

Insect damage to seeds and cones is expected to continue next season and the cone crop will continue to need insect protection on both orchards.

RECOMMENDATIONS

1. All orchard trees producing cones except white pine can be treated with Guthion(R) 2L at the rate of 6 pints per 100 gal. of water with a high volume sprayer for coneworms and seedworms. This insecticide is a highly hazardous organic phosphate.2/ The treatment should be applied until runoff. The first application should be made within 30 days after conelet closure with four additional applications at 30-day intervals during the season.

2. Where white pine cone beetles are a problem, the orchard manager should select 10-15 percent of the best producing white pine trees and treat individually with Furadan(R) 10G at the rate of 8 oz. per inch diameter. The Furadan(R) should be broadcast under the dripline, incorporated into the soil by raking and covered immediately with 1-2 inches of mulch such as wood chips or sawdust. The Furadan(R) would be applied once only in winter or early spring following label directions.

3. When pine sawfly colonies are found infesting seed orchard trees, spray with Sevimol(R)-4. Use 1 quart per 100 gallons and apply treatment until runoff.

4. Treat pine tortoise scale infested trees with Diazinon(R) AG 500 mixed at the rate of 1 pint per 100 gallons. Treatment will be applied when the crawlers are active. Approximately 3/4-gallon of dilutant per tree will be applied to the point of runoff.

5. Use Malathion 5-E for control of pine needle scale at the rate of 4 teaspoons per gallon of water. Apply to the point of runoff when crawlers are active.

6. Rubber boots, rubber gloves, rubber rain suits, and approved respirators should be used when applying Guthion(R). Rubber gloves, eye protection and approved respirator should be used when applying Furadan(R), Diazinon(R), Sevimol(R), and Malathion(R).

2/ The oral LD_{50} and dermal LD_{50} for Guthion(R) (technical grade) for rats are 11-13 mg/kg and 220 mg/kg, respectively.

LITERATURE CITED

Baker, Whiteford L. 1972. Eastern forest insects. USDA, Forest Service, M. P. 1175.

Nielsen, D. G. and Norman E. Johnson. 1973. Contribution to the life history and dynamics of the pine needle scale, Phenacaspis pinifoliae, in central New York. Abstract. Dept. Entomology & Limnology, Cornell Univ., N. Y. p. 34-43.

Wilson, Louis F. 1965. European pine sawfly. USDA, Forest Service. Forest Pest Leaflet 98.

APPENDIX I

Francis Marion Seed Orchard

A Review of Past Biological Evaluations and Surveys

A. 1976 - from 39 to 60 percent of the loblolly on March 22 were infested with Neodiprion excitans Rohwer while 34 percent of the Georgia shortleaf were infested.

B. 1975 - several cones from 20 clones were examined from both the Georgia and Marion loblolly sources. Identifiable seedbug losses averaged 2 percent and 12 percent, respectively. Losses by clone averaged from zero to 59 percent of the seed. Empty seed were 14 percent and 17 percent, respectively. Most of this loss can be associated with seedbug attack during the early summer of the second growing season.

C. 1975 - on March 7th tortoise scale infested 15 percent of the Georgia shortleaf and on April 22nd, 33 percent of the same seed source were infested.

D. 1974 - Dioryctria sp. attacked 25 percent of the harvested piedmont loblolly cone

E. 1974 - from 48 percent to 95 percent of the loblolly sources were infested with tip moth and from 14 percent to 27 percent of the longleaf were infested.

F. 1973 - 100 percent of the Georgia shortleaf were infested with tortoise scale.

G. 1973 - tip moth infested up to 19 percent of the Georgia shortleaf, 2 percent of the Georgia loblolly and 3 percent of the North Carolina loblolly.

H. 1973 - tortoise scale infested 12 percent of the Georgia shortleaf.

I. 1972 - in July tip moth infested from 1 to 27 percent of the loblolly and shortleaf pines.

J. 1972 - sawflies were found on 1 to 15 percent of the loblolly pine source.

K. 1972 - tortoise scale infested 1 percent of the Georgia shortleaf.

L. 1971 - in February tip moth attacked 87 percent of the Georgia shortleaf. In August 1 percent to 14 percent were infested.

M. 1971 - tortoise scale infested 9 percent of the Georgia shortleaf.

N. 1971 - sawflies infested .39 percent of the Piedmont loblolly.

O. 1971 - tip moth infested from 1 to 15 percent of the loblolly sources and 13 percent of the Georgia shortleaf.

APPENDIX 2

BEECH CREEK SEED ORCHARD

A REVIEW OF PAST BIOLOGICAL EVALUATIONS AND SURVEYS

A. 1975 - white pine 2.3 percent of seed lost to identifiable seed bug damage, 18.7 percent seed empty (probably seed bug).

B. 1974 - pine needle scale infested 57 percent of the Cherokee shortleaf and 20.3 percent of the North Carolina shortleaf pine.

C. 1973 - tip moths infested 69 percent of the Jefferson shortleaf and 38 percent of the Daniel Boone shortleaf.

D. 1973 - pine needle scale infested 5 percent of the Daniel Boone shortleaf.

E. 1973 - aphids infested 6 percent of the shortleaf.

F. 1973 - Dioryctria sp. attacked 6 percent of the Cherokee Virginia pine stems.

G. 1973 - Cherokee white pine had white pine aphids on 18 percent of the trees while the North Carolina white pine had 15 percent of the trees infested.

H. 1972 - forty-nine percent of the Daniel Boone shortleaf were infested with tip moth.

I. 1971 - thirty-two percent of the Cherokee Virginia pine were attacked by tip moth.

J. 1971 - white pine sawfly infested 4.2 percent of the North Carolina white pine.

K. 1971 - A sample of seed was X-rayed and 2 percent of the seed were damaged by seed bug (identifiable only).

APPENDIX 3

4110 Timber Management Research Programs December 12, 1975

Francis Marion Seed Orchard

Ollie Buckles, Moncks Corner, SC

I have just finished a cone analysis of your cones from the Furadan, Guthion control treatments from the Francis Marion Seed Orchard. I was surprised to see such a striking difference between the treatments. On the basis of the cones you collected you can expect to increase seed yield 197 seed/cone using Furadan and 27 seed/cone using Guthion.

The results of the cone analysis were as follows:

Treatment	Seed potential	Filled seed	Empty seed	Insect seed	Aborted ovules(1)	Aborted ovules(2)
Guthion	182	48.4	8.6	1.2	123.2	.2
Furadan	163	128.2	12.0	.8	21.0	1.2
Control	124	21.4	25.0	24.6	51.8	.8

A couple of things were unusual about the cones. The Furadan and Guthion cones were much larger which could be a result of more developing seed per cone. However, the Furadan and Guthion cones also had a higher seed potential (more fertile scales) which is difficult to explain. Do you know if there was any difference in the locations of the ramets such as fertilizer treatment that could explain the larger cones with more scales from the Furadan and Guthion areas? Also were the Furadan and Guthion treatments for two years or only in 1975?

The seed lab has not yet completed the cone analysis of the sample cones you submitted with CAS but I'll look at them when they start to work on them to compare to the insecticide treatments.

So, depending on how representative the control cones are of your orchard, it appears that you have a major insect problem. This was not so apparent when Larry, O.D., and I were there in November but you should start plans for some insect control in the near future. Larry Barber thinks that Furadan will be registered by late summer of 1976 but you may want some control before then.

For the controlled pollinations in your orchard, I think you have the right approach in increasing the quantity of pollen to the bag. Also, I would prefer to see you concentrate on a few of the six tree diallel crosses and check closely for reciprocal crosses. Remember that within any group one tree can be entirely female and one entirely male. Also try to work the dates of pollen shed to your advantage so you can avoid using stored pollen. You should also use some form of insect protection for the controlled-pollinated cones. Furadan would obviously be best but Guthion would be better than no insect control. You may even want to use screen wire cages if nothing else is available.

How to increase flower production of your loblolly is not easily answered. O.D. and I discussed subsoiling and this would probably be the best place to start. It would be helpful for future work to assign treatments to certain blocks to see if in fact the subsoiling did increase flower production. The difficulty of experimental treatments however is that it takes considerable time to accurately record the flower and cone production. My suggestion would be to subsoil some blocks of the South Carolina coastal loblolly in one direction, some both ways, and leave an area untreated. If responses are obvious then you may want to apply treatments to the entire orchard.

Likewise the fertilizer tests do not give a clear picture of rates to use on the orchard. Jim McConnell says that Jack May wants to continue the study. It would be interesting to sample cones from the fertilizer study to see if in fact the number of fertile scales and consequently the seed potential can be increased. If the study is continued through 1976 I'll try to work with you on sampling cones for analysis in 1976.

I am glad you sent some cones to Eastern Tree Seed Lab for analysis. This should give a reasonable estimate of seed losses. Again I was somewhat surprised to see the big increase from Furadan but this shows how high seed yields can be when insects are controlled.

I'll send a copy of this up to Larry Barber and Gary DeBarr who may have some helpful comments for insect control in your orchard.

Looking forward to seeing you in Atlanta in January.

Best regards.

DAVID L. BRAMLETT
Plant Physiologist

cc: John Kraus
Jim McConnell
O.D. Smith
Larry Barber
Gary DeBarr

APPENDIX 4

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

Forest Resource Protection
P.O. Box 5895, Asheville, N. C. 28803

REPLY TO: 5230 Evaluation

December 5, 1975

SUBJECT: Francis Marion Seed Orchard

TO: Supervisor, Francis Marion & Sumter NF's
Attention: O. D. Smith

The Francis Marion Seed Orchard was inspected for insect activity on October 16, 1975, by personnel from the Asheville Office. The primary objective of this inspection was to determine the status of the Nantucket pine tip moth, Rhyacionia frustrana Comstock, and the pine sawfly, Neodiprion excitans Rohwer, in the Georgia shortleaf source. Table 1 summarizes the results of the tip moth and pine sawfly evaluations.

Table 1. Tip moth and pine sawfly evaluations, October 1975.

Geographic Source	% of Infested Trees	
	Tip Moth	Sawfly
Georgia Shortleaf	28.8	47.9

Populations of the pine sawfly, N. excitans Rohwer, and red-headed pine sawfly, N. lecontei (Fitch), were scattered throughout the Francis Marion Seed Orchard. The evaluation indicated that the N. excitans made up 94 to 99 percent of the sawfly population. At the time of the evaluation, the defoliation ranged from light to medium. Control measures have been taken by seed orchard personnel.

Tip moth control should be continued in the Georgia shortleaf.

The pine tortoise scale population was almost negligible.

The shield-back pine seed bug population was at a very high level. One cone had eight seed bugs alone. The seeds from this cone will be X-rayed to determine the amount of damage present. Seed orchard personnel should continue to watch for a buildup of pine tortoise scale and sawflies during the next growing season.

Robert D. Wolfe

ROBERT D. WOLFE
Field Representative
Methods Application Group

cc: Turpie
Lambert
Belfiore